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A PRE-IMPOUNDMENT WATER QUALITY INVESTIGATION FOR THE PROPOSED GATHRIGHT RESERVOIR

ENVIRONMENTAL PROTECTION AGENCY

JUNE 1973

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A PRE-IMPOUNDMENT WATER QUALITY INVESTIGATION

for the

PROPOSED GATHRIGHT RESERVOIR

JUNE 1973

Field Operations Branch
Surveillance & Analysis Division
Environmental Protection Agency
Region III
Philadelphia, Pennsylvania

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The Environmental Protection Agency, Region III, was requested by the U. S. Army Corps of Engineers (Norfolk, Va. District) to conduct a preimpoundment water quality study on the Jackson River for the proposed Gathright Reservoir Project. The report describes a water quality survey of the Jackson River above Covington, Virginia.

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*Gathright Reservoir,
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Turbidity,
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Preimpoundment Study

of

Gathright Reservoir, Virginia

I. Introduction

The Environmental Protection Agency, Region III, was requested by the U. S. Army Corps of Engineers (Norfolk, Va. District) to conduct a pre-impoundment water quality study on the Jackson River for the proposed Gathright Reservoir Project. This correspondence, dated April 13, 1971, called for a water quality survey of the Jackson River above Covington, Virginia. Such a study is required by Section 5c of the Federal Water Pollution Control Act (PL 84-660) as amended by PL 87-80, PL 89-234, PL 89-753, PL 91-224 and PL 92-500.

The Gathright Dam and Reservoir project has been authorized since 1946 but the actual construction at the site was not begun until 1965. The project is now approximately 30% complete, with a scheduled target date of 1974 for completion. (1)

Personnel from the E.P.A., Charlottesville (Va.) field laboratory conducted field investigations on a monthly basis beginning in November, 1971, and ending in November, 1972. Long-term sampling was considered preferable to short-term intensive survey work for this project because of the relative purity of the water, the need to determine seasonal changes, if any, and to monitor any sediment production from the damsite itself.

II. Summary

The Gathright Reservoir impoundment will be located on the Jackson River near the point where the stream crosses the Alleghany-Bath County (Va.) line. The location is in west-central Virginia, draining 344 square miles of agricultural and forest land. Population densities are low and no industries or large municipalities are located within the boundaries of the drainage basin.

The reservoir will cover 2530 acres at the maximum conservation pool elevation of 1582 feet above mean sea level. The impoundment was designed by the Corps of Engineers to provide flood control, furnish flow augmentation, allow recreational development of the area and create a cold-water fishery zone downstream from the damsite. No previous water quality studies were made on that portion of the Jackson River above Covington, Virginia, because of the high water quality found in the upper reaches of the Jackson watershed.

Physical and chemical characteristics of the Jackson River basin waters are summarized below:

Physical		Chemical	
Parameter	Range	Parameter	Range
Temperature	3^{o} - $23^{o}C$	pH	6.9 - 8.3
Color	5 - 50 cobalt color units	Dissolved oxygen	8.5 - 13.6 mg/l
Turbidity	0.5 - 43 JTU	BOD_5	0.8 - 4.5 mg/l
Conductivity	66 - 380 umhos/cm^2	Total organic carbon (TOC)	1.- 6 mg/l
Hardness	17 - 235 mg/l as $CaCO_3$	Total phosphorus	0.007 - 0.15 mg/l
		Orthophosphate	0 - 0.15 mg/l

Physical		Chemical	
Parameter	Range	Parameter	Range
		Total iron	0.02-2.0 mg/l
		Total manganese	0-0.05 mg/l
		Sulfate	1-57 mg/l
Alkalinity	22-172 mg/l as $CaCO_3$	Chemical oxygen demand (COD)	0.3 - 54 mg/l
Total solids	38- 285 mg/l	Organic-N (TKN-NH_3)	0.09-0.9 mg/l
Suspended solids	0.4 - 59.6 mg/l	Inorganic-N (NO_2+ NO_3+NH_3)	0.025-1.975 mg/l

The biological characteristics are given below:

Parameter	Range
Bacteria	
Total coliform	8 - 2900/100 ml
Fecal coliform	0 - 920/100 ml
Fecal streptococci	0 - 640/100 ml

Macroinvertebrates

Groups present	clean water forms
Stoneflies	6 species
Mayflies	6 species
Caddisflies	8 species
Fishflies	1 species
Dobsonflies	1 species
Waterpennies	2 species
Rifflebeetles	1 species
Net-winged midges	1 species
Gill-breathing snails	1 species (3)

Groups present - intermediate forms

Clams	1 species
Damsel flies	3 species
Dragon flies	3 species
Midges	8 species
Craneflies	1 species
Snipeflies	1 species

Groups present - pollution tolerant forms

Air-breathing snails	2 species
Bristle worms	1 family

III. Conclusions

1. Nutrient concentrations are not great enough to cause any eutrophication problems upon impoundment.
2. Population trends are such that the region will remain essentially a minimum habitation area with no industry and only minor population concentrations to modify existing water quality levels.
3. Themal stratifcation will occur in the lake along with deoxygenation of bottom waters by virtue of the geometry (low width to depth ratio) which favors formation of a thermocline during summer months. Operation of the outflow is scheduled to be multi-outlet; hence, there will be problem insofar as dissolved oxygen content below the dam is concerned.
4. Bacterial content is generally within, or close to, the values given by NTAC (2) as "desirable" rather than the higher "permissible"

levels listed for drinking water standards. Contact recreation will not be effected by the observed bacterial levels.

V. Description of the Study Area

A. Jackson Watershed

The Jackson River rises in the Ridge and Valley physiographic province of west-central Virginia in Highland County. The river then flows southwesterly and parallel to Back Creek until its confluence with Back Creek near the town of Bacova, Virginia, in Bath County. The stream then continues to flow south-west to Covington where it turns east to join the cow pasture River near Clifton Forge, Virginia thus forming the James River.

The area is characterized by parallel to sub-parallel, heavily wooded ridges and generally open valleys developed in less resistant, intensely folded sedimentary rock sequences. Relief is moderate, becoming more pronounced in the headwater areas and hillsides are quite steep. The underlying limestones have developed some characteristics of Karst topography with underground openings of modest size.

There is little human habitation in the watershed above the impoundment site how much actual population density for the Highland-Bath County area was given as 6 to 10 people/mi^2 by 1970 census data. In spite of the low population density, the area lies within 200 airline miles southwest of downtown Washington, D. C. The prime cause of the low population density has been a poor transportation system and periods of inclement winter weather. Movement of people and supplies into and out of the area has been historically to the southwest along river valley, rather than across the ridges to the east.

Some farm activity is present in the area in the form of scattered sheep operations and a limited amount of crop agriculture is practices, including those crops raised to furnish food for wildlife in the game management areas. Agriculture such as described in the previous sentence is limited to the fertile bottom lands as the hillsides are relatively unfertile, as well as being excessively steep for efficient farm crop operations. A total of 6,446 acres of private land are included in the 12,362 acres of land acquired for the project but no actual farm acreage to be included in the project is given in the draft report from the Corps of Engineers.

B. Gathright Reservoir

The actual damsite location, as shown in Figure 1, is some 43.4 miles above the Jackson-Cowpasture River confluence and lies in a narrow passage through Cole Mountain. This opening, known as Kincaid Gorge, is a fault-controlled breach in limestone and sandstone sequences. This site is ideally located with regard to maximum impoundment with minimum construction, save for one factor.

The 257 foot high earth and rock fill structure will create an impoundment with 43.5 miles of shoreline. However, the precipitous slopes and the probability of drawn down under normal operating conditions will restrict the direct access areas into the project to the mouth of Hughes Creek and to the Bolar Mountain area near the mouth of Bolar Draft. The overall geometry of the reservoir is similar to western reservoirs, i.e., of limited surface area with a large depth/width ratio and quite deep as compared to the more general/reservoir situation in the eastern United States which is wide and shallow. At the latitudes of Virginia/stream reservoirs contain

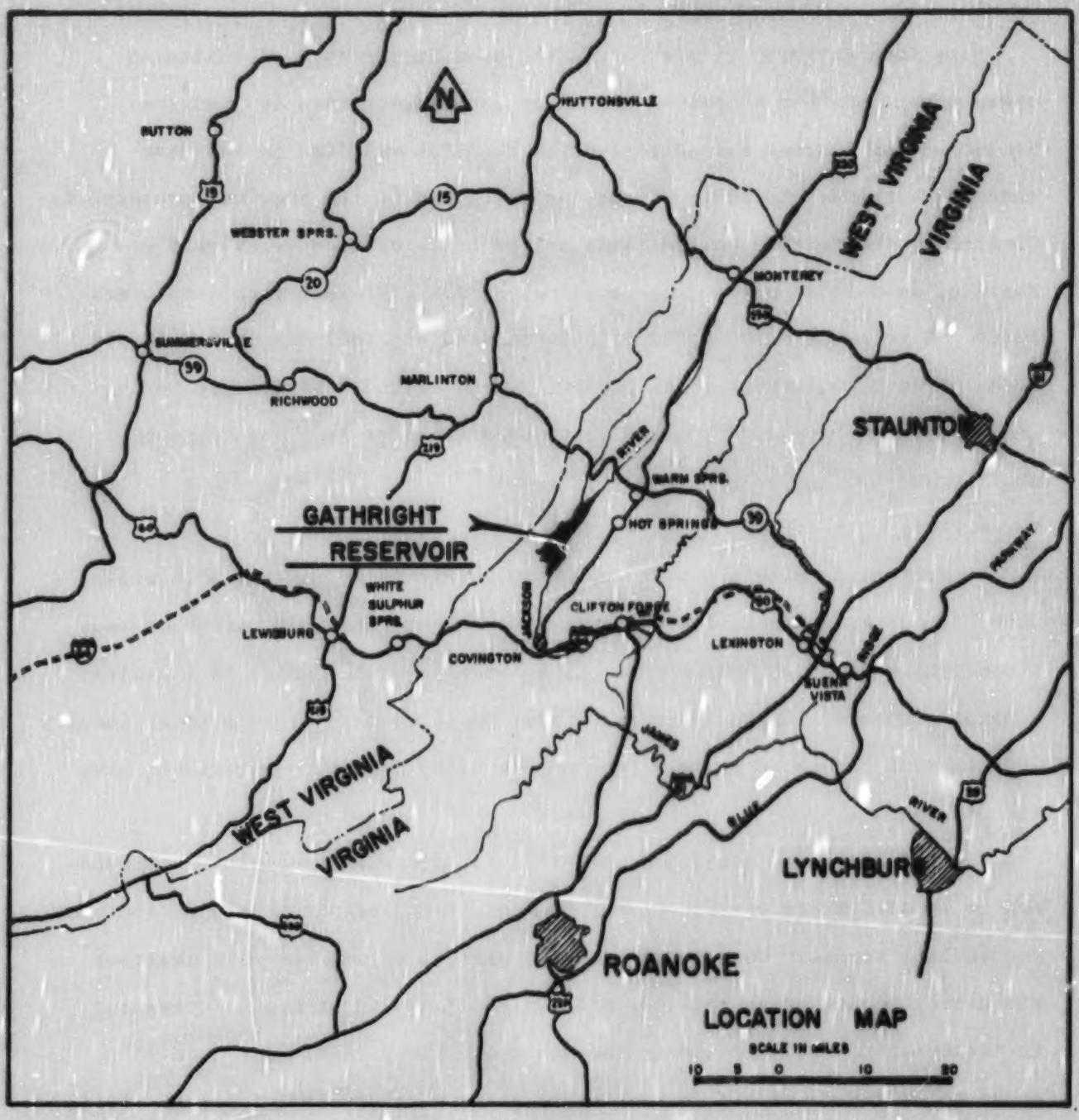
N
HUTTONSVILLE
RUTTON
WEBSTER SPRS.
SUMMERSVILLE
RICHWOOD
MARLINTON
MONTEREY
WEST VIRGINIA
VIRGINIA
STAUNTON
GATHRIGHT
RESERVOIR
WARM SPRS.
HOT SPRINGS
WHITE
SULPHUR
SPRS.
LEWISBURG
COVINGTON
CLIFTON FORGE
LEXINGTON
BUENA
VISTA
JAMES
RIVER
WEST VIRGINIA
VIRGINIA
LYNCHBURG
ROANOKE
LOCATION MAP
SCALE IN MILES
10 5 0 10 20

FIGURE 1

WATER RESOURCES RESEARCH CENTER

VIRGINIA POLYTECHNIC INSTITUTE and STATE UNIVERSITY

NEWS

BLACKSBURG, VIRGINIA 24061

VOLUME 2 NOVEMBER 1971 NUMBER 8

JAMES RIVER BASIN ASSOCIATION

The James River Basin Association met on October 21, hearing reports on various developments in the basin.

Col. James H. Tormey, District Engineer, Norfolk District, Corps of Engineers, gave a progress report on the Gathright project and indicated that deepening the James River Shipping Channel does not appear to be economically justified. He also revealed that a preliminary study of the Buena Vista flooding problem indicates the use of flood walls as the best alternative.

Mr. A. E. Graybill, member of the Botetourt County Board of Supervisors, spoke in favor of the Hipes Dam and Reservoir on Craig's Creek emphasizing the economic benefits to be realized from construction payrolls, land purchase, and tourism and recreation following completion of the project.

Mr. James M. Hagood, Jr., Supervisor, Hydroelectric Engineering, VEPCO, reported on two pumped-storage projects under consideration, one in Bath County and one near Poor Mountain in Roanoke, Montgomery, and Floyd Counties. Topographic studies are complete, and test drilling is now in progress. VEPCO hopes to make final site selection by next spring and to complete the project by 1979.

The Association unanimously passed a resolution requesting Congress to officially name the Gathright project the "Ben C. Moomaw Dam and Lake," honoring Mr. Moomaw, who has "devoted more than a quarter of a century as an ardent champion of all phases of water and recreational resources...." Mr. Moomaw has been instrumental in securing construction of Gathright.

Representative Richard H. Poff (R-Va.) introduced legislation in the House on November 4 designed to implement the resolution. In his statement Poff said, "Ben Moomaw has championed projects in all phases of water resources development and recreation generally, and the Gathright dam project in particular." The bill was referred to the House Committee on Public Works.

GATHRIGHT PROJECT

The Gathright Dam and Reservoir project, in the rugged mountains of Alleghany County, Virginia, has been in the works since its initial authorization by the Congress in 1946. After being deferred for restudy in 1957, the project was reactivated for construction in 1965 and is now about 30% complete, with completion scheduled for 1974. Col. James H. Tormey, District Engineer, Norfolk District Corps of Engineers, made this statement to a meeting of the James River Basin Association on October 21. Meeting at Hot Springs, Va., the Association heard Col. Tormey state that about one-half of the land to be covered by the completed reservoir has been purchased.

water/quite warm (in summer). These conditions, and their potential effect upon impoundment water quality will be discussed under "Environmental Impacts of Impoundment".

A total of 12,362 acres lie within the project area and some 9,832 acres will remain above the projected 1582 foot maximum conservation pool elevation. The principal water sources into the pool are the Jackson River and Back Creek. The long-term characteristics of stream flow in Back Creek and Jackson River, below the proposed damsite, are 166 cfs for 20 years of record (Back Creek near Mountain Grove) and 472 cfs for 46 years of record (Jackson River at Falling Spring) as shown in Figure 2.

C. The Study Area

The river bed in the project area is alternately flat with coarse sand and gravel overlying bedrock outcrops to steeper reaches containing gradients approaching 40 feet/mile. In these steeper areas, little, if any sediment buildup occurs. Stream flow velocities approach 2 feet/second and K_2 (re-aeration) values are high. The stream flow vs time plot is extremely variable, a common condition in limestone terrains where soil cover is limited and bedrock porosities preclude large volumes of water being held in storage. The ground water which is present is confined to solution cavities and solution-enlarged joint planes. This condition results in very low flows during the dry summer months with a concommitant rise in water temperature past the upper survival level threshold for trout. Outlet structures planned for inclusion into the proposed dam will allow a proper temperature/D.O. content of the release water to maintain a cold water fishery area for some 10 miles below the dam.

Figure 2 - Long-term flow data and station data

James River Basin

Jackson River at Falling Spring, Va.

Location.--Lat 37°52'36", long 79°58'39". Alleghany County, on right bank 20 ft. upstream from Smith Bridge, 0.8 mile south of town of Falling Spring, 1.6 miles downstream from Falling Spring Creek, and 5.5 miles north of Covington.

Drainage Area.-- 411 sq. mi.

Period of Record. --April 1925 to current year. Prior to October 1934, published as "at Barber."

Gage.-- Water-stage recorder. Datum of gage is 1,333.49 ft. above mean seal level (levels by Corps of Engineers). Prior to Oct. 26, 1934, non-recording gage at same site and datum.

Average Discharge.--46 years, 472 cfs (15.60 inches per year).

James River Basin

Back Creek Near Mountain Grove, Va.

Location (revised).--Lat 38°04'10", long 79°53'50". Bath County, on left bank 0.3 mile downstream from Cummings Run, 0.8 mile downstream from bridge on State Highway 39, and 2.1 miles south of Mountain Grove.

Drainage Area. --134 sq. mi.

Period of Record.--October 1951 to current year.

Gage.--Water-stage recorder. Datum of gage is 1,701.45 ft. above mean sea level.

Average Discharge.--20 years, 166 cfs (16.82 inches per year).

Cooperation.--Records computed and furnished by the Virginia Department of Conservation and Economic Development, Division of Water Resources

D. Water Supply and Waste Sources

The Commonwealth of Virginia classifies the Jackson River and its tributaries above the reservoir site as Class IV A - Public Water Supply. Specific water quality criteria from the Commonwealth of Virginia are given in Appendix A. No industrial or municipal water supply withdrawals from the river occur above the proposed reservoir site, although the towns of Warm Springs and Hot Springs consume approximately 0.2 MGD from ground water sources. Private wells supply small amounts of water to domestic users, but locally may have objectionable levels of iron, sulphur, hardness or corrosiveness.[3] These conditions are a natural result of ground water being invaded by heated water rising from greater depths and appearing at the surface as "hot" or "warm" springs.

Only very small discharges of municipal sewage occur above the reservoir site as shown in Table 1. Population density, a direct reflection of the topography land use and distance from population centers, is very low.

The lower portion of the watershed immediately above the damsite (Bath County) has a population density just short of 10 persons/mi^2. The upper basin (Highland County) has an even lower population density of 6 persons/mi^2. These figures, from the 1970 census data, also show a general population. Pollution, therefore, from municipal or industrial sources is not a factor in pre-impoundment water quality studies of the upper Jackson River-Back Creek Watershed.

VI. Study Methods

A. Sampling Stations

Five sampling stations were chosen in the sampling program as shown in Figure 3. One station was on Back Creek, the second station was on the

TABLE 1. Wastewater Discharges in Project Area

Jackson River (above dam site)

Discharger	Percent Treatment	Receiving Stream	Flow, design MGD	Flow, actual MGD
Bacova	60	Unnamed tributary	-	0.050
Smiths Trailer Park	80	Unnamed tributary	-	0.020
Hot Springs Twin Terrace Motel	80	Rowan Run	-	0.003
Warm Springs Sanitary Commission	35	Warm Springs Run	0.060	0.028
		Total input flow above dam site	-	0.101

Cedar Creek (below dam site)

Ashwood-Healing Springs Sanitary District Comm.	85	Cascades Creek	0.080	
Hot Springs	60	Hot Springs Run	0.150	0.600*
		Total input flow below dam site	-	0.680

*Facility exceeding design flow.

The lower portion of the watershed immediately above the damsite (Bath County) has a population density just short of 10 persons/mi^2. The upper basin (Highland County) has an even lower population density of 6 persons/mi^2. These figures, from the 1970 census data, also show a general population decline in the area reflecting steady reduction in farm population. Pollution, therefore, from municipal or industrial sources is not a factor in pre-impoundment water quality studies of the upper Jackson River-Back Creek Watershed.

VI. Study Methods

A. Sampling Stations

Five sampling stations were chosen in the sampling program as shown in Figure 3. One station was on Back Creek, the second station was on the Jackson River above the Back Creek confluence, a third station was located on the Jackson below the Back Creek confluence, but the above the proposed damsite, a fourth station was located on the Jackson below the proposed damsite and below the Cedar Creek confluence and the last station was located on Cedar Creek.

Mid-channel samples or samples taken at mid-points of greatest flow were utilized for sample analyses. A singel sample collected below the water surface was considered sufficient because of the relative homogeneity, clarity width, and shallowness of the streams at the sampling stations chosen in this study.

The location of the sampling stations is shown schematically in Figure 3 and the detailed enlargements of the map segments showning station location is given in Figure 4a to 6. A station description for the sample network appears in Appendix B.

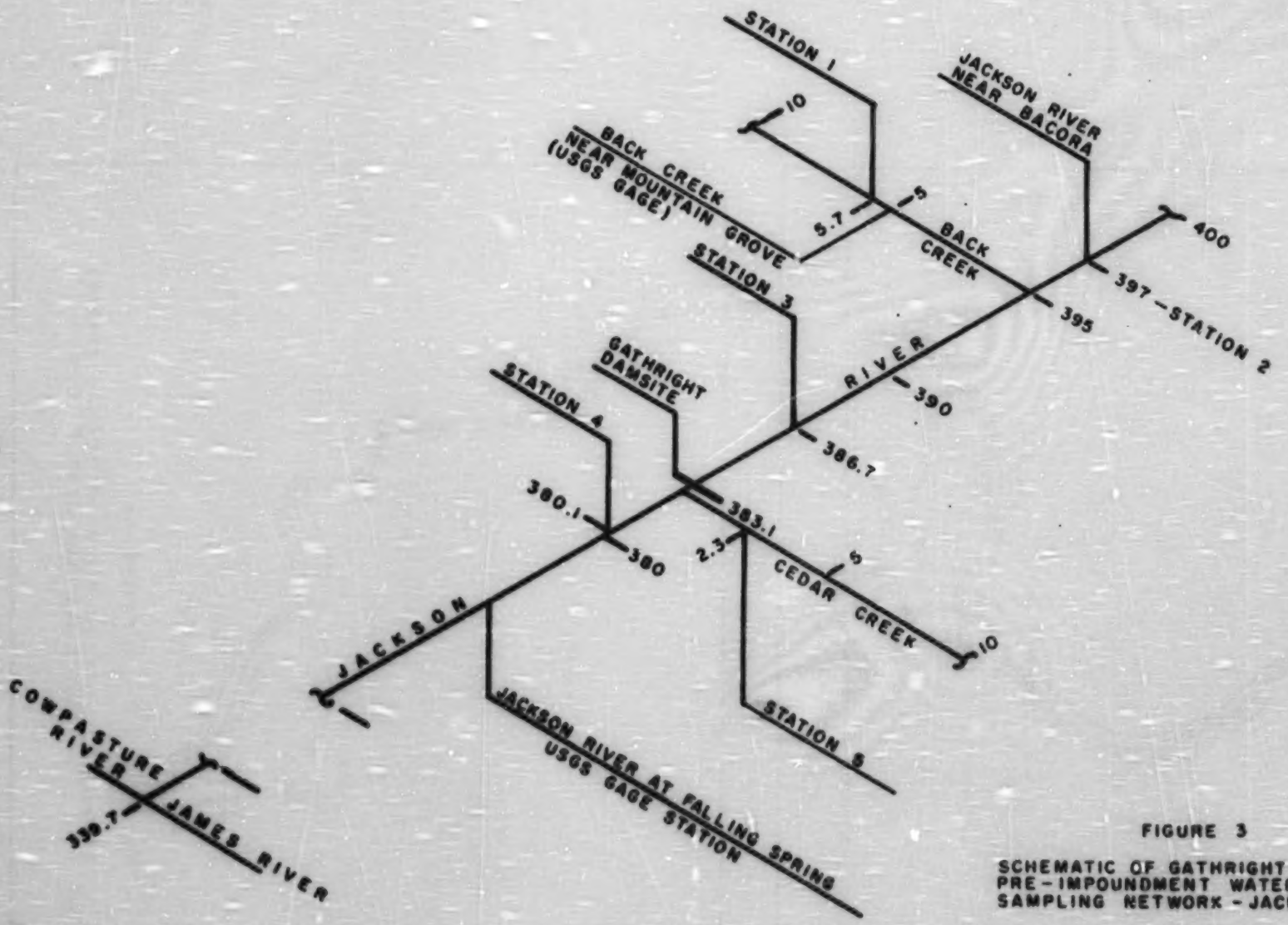

FIGURE 3

SCHEMATIC OF GATHRIGHT RESERVOIR PRE-IMPOUNDMENT WATER QUALITY SAMPLING NETWORK - JACKSON RIVER

FIGURE 4a
STATION 1 - JACKSON RIVER NEAR MOUNTAIN GROVE

FIGURE 4b
STATION 2 - JACKSON RIVER AT BOILING SPRINGS
ROD & GUN CLUB NEAR BACORA

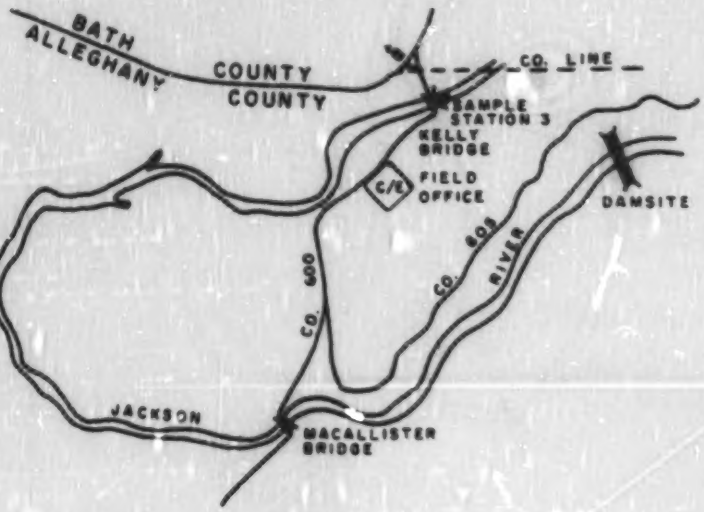

FIGURE 5a

STATION 3 – JACKSON RIVER AT KELLY BRIDGE

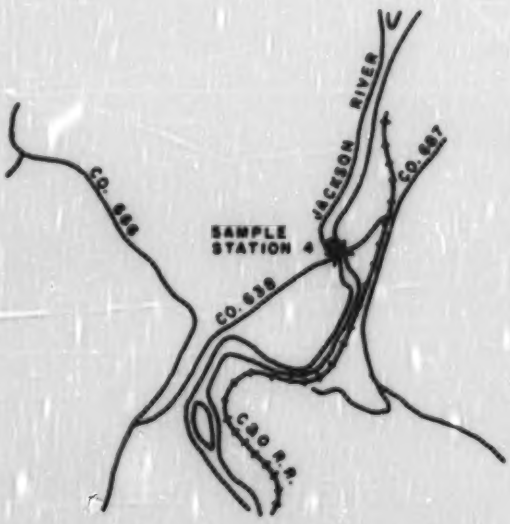

FIGURE 5b

STATION 4 – JACKSON RIVER AT NATURAL WELLS

FIGURE 5c

STATION 5 – CEDAR CREEK NEAR CALLISON, VA.

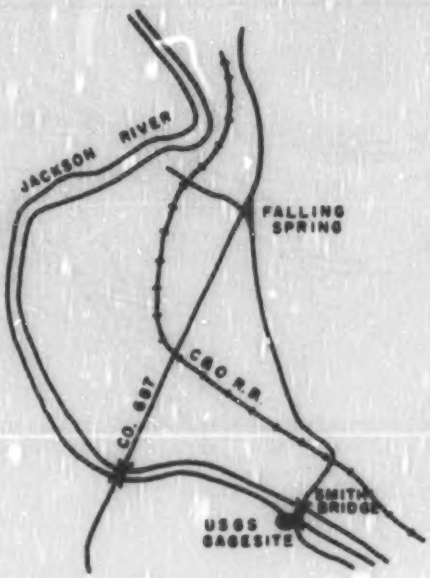

FIGURE 6
USGS GAGE STATION AT
FALLING SPRINGS, VIRGINIA

Jackson River above the Back Creek confluence, a third station was located on the Jackson below the Back Creek confluence, but above the proposed damsite, a fourth station was located on the Jackson below the proposed damsite and below the Cedar Creek confluence and the last station was located on Cedar Creek.

Mid-channel samples or samples taken at mid-points of greatest flow were utilized for sample analyses. A single sample collected below the water surface was considered sufficient because of the relative homogeneity. clarity width, and shallowness of the streams at the sampling stations chosen in this study.

The location of the sampling stations is shown schematically in Figure 3 and the detailed enlargements of the map segments showing station location is given in Figure 4a to 6. A station description for the sample network appears in Appendix B.

B. Sampling Schedule

The sampling schedule was initiated on a monthly basis for twelve consecutive months following the initial sample pickup. Some difficulty was encountered in obtaining winter samples because of snow-clogged, impassable secondary roads in the project area. However, the collection of December and February samples was deemed sufficient to delineate winter water quality conditions, even though the January and March samples proved impossible to obtain.

Samples collected on the survey were returned to the Charlottesville Field Lab for processing on the same day as collected. All samples were field fixed or preserved on ice without being analyzed in the field. The

only parameters read in the field were temperature of the water, pH and stream flow where no gages existed. Water chemistry analyses were performed according to techniques outlined in Standard Methods (4).

Biological and bacteriological samples were collected and processed according to existing recommended techniques. The report and evaluation of each section is given in Section E.

VII. Study Findings

A. Previous Studies

There are no prior detailed studies exclusively on the Jackson River above Covington, although studies exist for the James River Basin as a whole. Westvaco and the State of Virginia have taken water quality samples above Covington but no samples have been taken for at least the past ten years;hence, a situation exists where, for all practical purposes, no water quality studies have been made. Because of the remoteness of the area, its lack of development and the terrain in the Jackson River above Covington, we have what is essentially a pollution free river segment which furnishes us a baseline for water quality investigations.

B. Project Studies 1971 - 72

Data from the samples collected between July, 1971, and September, 1972, are presented in this section to illustrate the variation in water quality parameters with changing discharge and season. No statistical summation has been attempted because of the very low values encountered for some parameters. These low values have been reported as "less than" a certain value; hence, are not amenable to statistical manipulation. Raw data for the five stations is given in Appendixes C to G.

C. Rainfall and Stream Flow

Summaries of the daily rainfall at Hot Springs, Virginia some 10 miles east of the proposed reservoir site can be found in the National Oceanic and Atmospheric Administration publication titled "Monthly Summarized Station and Divisional Data". The daily mean stream flow discharge for the Jackson watershed gaging stations may be found in the US Geological Survey publications titled "Water Resources Data for Virginia" in the appropriate year. Stream gage station descriptions are given in Figure 2.

A comparison of the actual rainfall/stream flow data is given in Table 2. This table indicates a smaller total rainfall amount is needed to increase stream discharge during winter months than is the case in the summer period. Increased runoff during the winter is due to (1) higher soil moisture content (2) likelihood of frozen ground creating temporary imperviousness (3) lack of foliage to intercept part of the rainfall and (4) minimized evapotranspiration. Greater rainfall amounts are needed in the summer months to creat increased runoff for the reverse of the conditions stated above. Although not shown in any direct way, a very large discharge occurred in the Jackson watershed at the end of June 1972. This event was caused by Hurricane Agnes-induced rainfall and caused some temporary modification of water quality and stream biota. Conditions quickly returned to normal and stream conditions were nearly at equilibruim by the termination of sampling in September 1972.

Table 2. Antecedent Rainfall and Stream Flow Conditions at USGS Gage (Jackson River at Falling Springs, Va.)

Station 4 Sample Date	Rainfall at Hot Springs, Va. Date	Amount, In.	Jackson River at Falling Springs, Va. Date	Flow, Cfs	Station 4 Sample Date	Rainfall at Hot Springs, Va. Date	Amount, Inc.	Jackson River at Falling Springs, Va. Date	Flow, CFS
			7/6/71	194		7/28/72	0.11	7/28/72	368
	7/7/71	1.12	7/7/71	198		7/29/72	1.38	7/29/72	2390
7/8/71			7/8/71	188		7/30/72	1.53	7/30/72	3300
						7/31/72	0.22	7/31/72	1970
	10/2/71	0.61	10/2/71	258	8/1/72	8/1/72	0.02	8/1/72	1150
	10/3/71	0.02	10/3/71	246					
			10/4/71	223		9/4/72	0.10	9/4/72	146
	10/5/71	0.02	10/5/71	210		9/5/72	0.02	9/5/72	146
10/6/61			10/6/71	196		9/6/72	0.08	9/6/72	147
								9/7/72	143
			11/15/71	182	9/8/72			9/8/72	135
			11/16/71	173					
			11/17/71	166					
11/18/71			11/18/71	162					
	12/6/71	0.06	12/6/71	347					
	12/7/71	1.11	12/7/71	3110					
	18/8/71	0.07	12/8/71	3490					
			12/9/71	1600					
			12/10/71	1100					
			12/11/71	843					
			12/12/71	658					
12/13/71	12/13/71	0.03	12/13/71	567					
			2/20/72	588					
			2/21/72	490					
			2/22/72	518					
			2/23/72	643					
2/24/72	2/24/72	0.53	2/24/72	1150					
			4/3/72	334					
	4/4/72	0.07	4/4/72	319					
			4/5/72	317					
4/6/72			4/6/72	291					
			5/1/72	501					
	5/2/72	0.30	5/2/72	462					
	5/3/72	1.30	5/3/72	641					
5/4/72	5/4/72	0.10	5/4/72	1410					

Table 2. (cont'd.) Antecedent Rainfall and Stream Flow Conditions at USGS Gage (Jackson River at Falling Springs, Va.)

Station 4 Sample Date	Rainfall at Hot Springs, Va. Date	Amount, inc.	Jackson River at Falling Springs, Va. Date	Flow, Cfs
			6/4/72	275
			6/5/72	257
			6/6/72	243
	6/7/72	0.09	6/7/72	241
6/8/71			6/8/72	228

Station 4 Sample Date	Rainfall at Hot Springs, Va. Date	Amount, inc.	Jackson River at Falling Springs, Va. Date	Flow, CFS

D. Physical and Chemical Results

1. Temperatures

The monthly average temperature maxima and minima for Hot Springs, Virginia, from NOAA records are given in Table 4. The average annual air temperature at this station is 50°F. This station is approximately 10 miles east of the project area but somewhat greater elevation (2200 feet vs. 1400 feet); hence, the temperature extremes at the project site would be slightly different. Given temperature extremes at Hot Springs from NOAA climatological records are shown as 20°F to +99°F (-28°C to +37°C).

The observed range in water temperatures for the project site were +3°C to +23°C. The actual maxima and minima for water temperatures during the project were probably about +26°C and 0°C, the latter almost certainly occurring on several days during winter months. A combination of wide temperature variations and erratic stream flows (Section VII C) results in the exclusion of trout from what would otherwise be prime fishing area. The upper temperature limit for trout (LD_{50}) is about 23 to 25°C for 133 hours. However, a physiological threshold lies at about 17.2°C (5) where trout are very sluggish and nearly unable to catch food minnows. Therefore, maintenance of a more stable flow of cooler, well oxygenated water from an impoundment would greatly enhance the fishery potential of the Jackson River some distance downstream from the damsite location.

2. Color and Turbidity

Color and turbidity were quite low and, with certain exceptions, well within the desired water quality limits required given by Virginia State Water Quality Standards. Color values ranged from a low of 5 color cobalt units in many samples to singe examples at 20 and 50 color cobalt units. The latter value was recorded during spring runoff in February of 1972 on Cedar Creek which joins the Jackson below the damsite location. Turbidity, a measure of sedimentary and organic colloid particles, ranged from a low of 0.5 to a high of 43. The latter value was observed in the same sample as the high color reading.

Color and turbidity were both effected by variation in stream flow with turbidity being, as expected, more dependent upon flow than color. Higher color values in late winter to early spring samples reflect runoff from decaying leaf litter on the surrounding wooded hillsides.

3. pH and Conductivity

The observed pH values (field determinations) varied from a low of 6.9 to a high of 8.6 with the majority of the readings being between 7.0 and 8.0. These values are consistent with water draining land underlain by carbonate rocks and should be slighly higher during summer months under the influence of phytoplantonic photosynthesis.

Conductivity, a measure of dissolved mineral content, ranged between a low of 66 to a high of 380 umhos/cm^2. Values were controlled by flow with low flow periods having the greater conductivity. The conductivity values also increased downstream during the summer months, but remained essentially constant during winter months reflecting more stable flow conditions.

4. Total and Suspended Solids

Total solids, a summation of dissolved and suspended solids, remained quite low throughout the sample period. Values ranged between a low of 38 on Back Creek in December, 1971, to a high of 285 mg/l on Cedar Creek in June of 1972. Observed values fluctuated with stream flow but the correlation was not altogether predictable. Suspended solids, on the other hand, remained quite low during the sample period. Values ranged from a minima or 0.4 mg/l to a high of 59.6 mg/l. Most values fell between 1 and 10 g/l reflecting the general scarcity of suspended sediments being produced from forest and uncultivated lands in the watershed.

5. Alkalinity and Hardness

The desired concentration of alkalinity for drining water supplies is given by NTAC as between 30 and 500 mg/l. Analytical results for the Jackson waters show most values between 30 and 100 mg/l with a few excursions below the 30 mg/l threshold and a few values greater than 100mg/l on Cedar Creek. This fair buffering capacity reflects the extensive outcrops of limestone in the area.

Most of the hardness observed in the Jackson waters appears to be carbonate hardness as shown by the general correlation between alkalinity and hardness values. However, some non-carbonate hardness was noted, especially in samples taken during low flow periods during fall months. Hardness values ranged between a low of 17 mg/l on Back Creek in April, 1972, to a high of 235 mg/l for the Sept. 8, 1972, at Cedar Creek. The general range of hardness values fell between 35 and 95 mg/l, which classifies the water as moderately hard during low flow periods and soft during high flows. Non-carbonate hardness appears at all stations during summer low flow periods.

6. Nitrogen and Phosphorous

Concentrations of nitrate-nitrite as nitrogen varied from a low of less than 0.014 gm/l at Station 4 on April 6, 1972, to a high value of 1.970 at Station 2 on August 1, 1972. The general range of values was from 0.1 to 0.4 mg/l. The samples taken on August 1, 1972, indicated greater than normal concentrations of both nitrogen and phosphorous. No specific reason for this increase can be stated with certainty, but the samples were taken during a high runoff period; hence, it is assumed these results are associated with the runoff.

Phosphorous concentrations were quite low, mostly in the 0.01 to 0.05 mg/l range with some samples exceeding the 0.05 mg/l limit considered allowable for waters entering a lake. Limiting values for preventing excess algal growth is given by Maekenthun[6], on p. 133, as 0.1 mg/l N and 0.009 Mg/l P or less while concentrations of phosphorous above 0.05 mg/l may lead to an uncontrolled algal growth known as a "Bloom". Concentrations of N and P which are less than 0.9 and 0.09, respectively, are less than optimal but necessarily limiting. Phosphorus, generally present in lower concentrations than nitrogen, is usually the limiting factor in aquatic plant growth.

7. Total Organic Carbon (TOC) and Chemical Oxygen Demand (COD)

The purpose of these two tests is to determine the approximate amount of oxygen demanding organic material present in river water samples. Although tests tests may not include all of the organic compounds available to the biota of the stream and may also include some substances

(principally cellulose) which are not generally available to the biota as an energy source, they are useful in that the results are (1) immediately available, and (2) the tests are not subject to toxic substance effects.

The values of TOC ranged from a low of 1 mg/l at Stations 2, 3 and 4 on July 8, 1971, to a high of 6 mg/l at Stations 1 and 2 on April 5, 1972, at high flows. These values are well within reasonable limits needed for maintaining a balanced ecology in the stream environment. COD values are seen to be greater, due principally to the heavy forest and grass cover which produces large amounts of cellulose materials.

8. Dissolved Oxygen and Biochemical Oxygen Demand

With the exception of the July 8, 1971 sample on Back Creek, the 5 day biochemical oxygen demand (BOD_5)/dissolved oxygen (D.O.) ratio remained close to a value of 0.15. These ratios, shown in Table 5, may serve as an indicator for general stream conditions with regard to the health of the stream if monitored over a long term time span for trends. Those streams which are well aerated, contain little pollutant material and are freeflowing, seem to have BOD_5/DO ratios between 0.09 and 0.25.

Percent saturation of the dissolved oxygen in the Jackson River waters ranged between 90 and 105 percent. The lower values reflect essentially natural background conditions free from pollutants. No trends were noted because of the near saturation levels for oxygen in water seen at all stations. The lowest O_2 value recorded at Station 1 on June 8, 1972, was 8.5 mg/l. This value was still 92% of the satura-

Table 3 - BOD_5/DO Ratio for Jackson River Stations above Covington, Virginia

Station Number	7/8/71	10/6/71	11/10/71	12/13/71	2/24/72	4/6/72	5/4/72	6/8/72	8/1/72	9/8/72
1	0.511	0.110	0.096	0.073	0.089	-	0.103	0.118	0.105	0.109
2	0.140	0.106	0.113	0.127	0.081	-	0.109	0.103	0.042	0.103
3	0.137	0.225	0.255	0.073	0.081	-	0.108	0.114	0.105	0.110
4	0.097	0.104	0.106	0.106	0.315	-	0.109	0.107	0.108	0.108
5	-	0.096	0.081	0.073	0.083	-	0.099	0.093	0.105	0.098

tion value for the altitude (1400 feet) and water temperature (22°C). The highest O_2 value recorded, 13.6 mg/l was probably super-saturated, although no water temperature was recorded at the sample site.

9. Iron and Manganese

The observed values for iron and manganese ranged from a low of 0.02 mg/l (Fe) on July 8, 1971, at Station 1, to a high of 2.0 mg/l on February 24, 1972. Manganese values varied between zero concentration at several stations on July 8, 1971, to a high of 0.05 mg/l on February 24, 1972. Manganese values varied between zero concentration at several stations on July 8, 1971, to a high of 0.05 mg/l at several stations in late 1971. The recommended limits for iron and manganese is given as 0.3 and 0.05 mg/l, respectively (NTAC). Concentrations of iron and manganese were higher in the Jackson than in Back Creek and Cedar Creek. Such concentration probably reflects particulate material in sediments rather than a true solution value. This is especially true of the well-aerated, alkaline-pH waters of the upper Jackson watershed. The highest concentration levels of iron were associated with the highest discharges but no correlation was seen for manganese.

10. Sulfates

Sulfate concentrations were extremely low, many values being less than 10 mg/l. The highest values recorded were 57 mg/l on October 6 and November 18, 1971, at Station 5. The limit for sulfate concentration in drinking water is given as 350 mg/l; hence, there is no potential problem posed by the sulfate concentration in the Jackson River system.

E. Biological Results

1. Bacteriological

The bacterial analyses indicate minor pollution from animal sources at certain periods of the year (Appendix C thru G). These periods appear to coincide with major flow events during warmer summer months. Coliform populations during winter months decreased to very modest levels. The desired bacterial concentrations for drinking water supplies are given as 100/100 ml for total coliforms and 20/100 ml for fecal streptococci organisms. Concentrations in the project samples ranged from a low of less than 4 total coliform organisms/100 ml in April of 1972 for Stations 2, 3 and 4, to a high of 2900/100 ml at Station 2 on February 24, 1972. Fecal coliforms ranged from a low of zero (no organisms cultured) at Stations 3 and 4 in April of 1972, to a high of 640/100 ml at Station 3 in November, 1971.

The ratio between fecal and fecal streptococci populations is an indicator of the type of animal responsible for the pollution. A ratio of fecal coliforms to fecal strep organisms greater than 1:1 usually indicates human pollution, while values less than 1:1 usually indicate animal pollution present. Ratios observed during the Gathright project were mixed with decreasing ratios being noted downstream, especially during high flow/runoff periods. Inasmuch as Station 4 is located below a higher than normal wild animal population area (wildlife game management preserve), the decrease in the FC/FS ratio probably can be accounted for in this fashion.

The correspondence concerning the bacteriological results is included

in the Appendices. There is a slight amount of human waste being discharged into the stream above the impoundment, but the volume is very small in comparison with the total stream flow at the same location.

2. Macro-invertebrates.

The macro-invertebrate population was indicative of very clean water with only six groups of intermediate organisms and two groups of pollution tolerance organisms (Appendix H). Small numbers of individuals but many species is a mark of a heterogeneous, non-stressed environment. The remainder of the species recovered were pollution-sensitive forms which disappear rapidly in the presence of pollution. Quantitative results were not possible at some stations due to rocky bottoms which, although clean water is present, presents a generally unfavorable sub-strata for bottom-dwelling organism development thereby reducing the actual number of organisms present. A second sampling survey, made on October 9, 1972, recovered a smaller number of different species. This decrease is attributed to the scouring and flushing of organisms under the influence of Agnes-induced flood flows. The peak flow, at Station 2, from these hurricane-spawned intense rains was estimated to be approximately 7000 cfs., which is many times greater than the 600 cfs. maximum flow observed during the survey.

Table 4 - Chemical & Bacteriological Quality Variations in Jackson River System above Covington, Va.

Parameter	NTAC* Permissible Criteria	NTAC* Desirable Criteria	Station 1		Station 2		Station 3		Station 4		Station 5	
			Low	High	Low	High	Low	High	Low	High	Low	High
Total coliforms	10,000/100ml	100/100ml	8	720	4	2900	24	1800	4	1000	20	1500
Fecal coliforms	2,000/100ml	20/100ml	1	200	2	920	0	660	0	600	1	480
Fecal Strep	Not established	Not established	2	220	2	300	0	640	0	420	6	510
NH_3-N	0.5	0.01	0.005	0.05	0.005	0.22	0.005	0.55	0.005	0.05	0.005	0.32
NO_3N+NO_2N	10	Virtually absent	0.043	1.55	0.015	1.970	0.015	1.690	0.014	1.800	0.123	1.100
D.O.	4.0	Near saturation	8.5	11.4	9.2	12.3	8.8	12.4	9.2	12.7	9.5	13.6
BOD	Not established	Not established	0.8	4.5	1	1.4	0.8	2.8	1	4	0.8	1.1
Total Solids	500	200	38	133	84	176	57	167	67	171	172	285
Hardness	Not established	300	17	60	33	114	30	100	26	119	47	235
Total Phosphorus	Not established	Absent	0.01	0.035	0.015	0.145	0.01	0.05	0.007	0.04	0.05	0.15
SO_4	250	50	1	8	6	18	4.2	16	4	28.3	13	57
Fe	0.3	Virtually absent	0.05	0.27	0.05	0.8	0.05	0.31	0.05	0.7	0.03	2.0
Mn	0.05	Absent	0	0.05	0	0.05	0	0.05	0	0.05	0.02	0.05
COD	Not established	Not established	0.6	26	1.7	11	1.6	8.6	1.3	8.6	0.3	54
TOC	"	"	2	6	1	6	1	5	1	5	2	5

*National Technical Advisory Committee, FWPCA, April, 1968.

Appendix A

1.00 RULES WITH GENERAL STATE-WIDE APPLICATION

1.01 All waters within this State shall at all times be free from all substances attributable to sewage, industrial wastes, or other wastes in concentrations or combinations which contravene established standards or interfere directly or indirectly with beneficial uses of such waters; except that limited zones will be permitted for the mixture of treated sewage, treated industrial wastes, and other waste effluents with receiving waters. The boundaries of mixing zones will be determined on a case by case basis. However, these zones shall generally occupy as small an area and length as possible, and shall not prevent free passage of fish or cause fish mortality.

1.02 Stream standards will apply whenever flows are equal to, or greater than, the minimum mean 7-consecutive day drought flow with a 10-year return frequency.

1.03 In lakes and impoundments the temperature of the epilimnion, in those areas where important organisms are most likely to be adversely affected, shall not be raised more than $3^{\circ}F$, above that which existed before the addition of heat of artificial origin. The increase is to be based on the monthly average of the maximum daily temperature. Unless a special study shows that a discharge of heated effluent into the hypolimnion (or pumping water from the hypolimnion for discharging back into the same water body) will not produce adverse effects, such practice shall not be approved. Maximum temperatures consistent with the standards established for waters immediately

above and below the lake or impoundment will be established for these waters.

1.04 Any tributary stream which is not named in a specific section description, or otherwise, shall carry the same classification and standards of quality assigned to the stream or section to which it is tributary.

1.05 In addition to other standards established for the protection of public or municipal water supplies, the following standards will apply at the raw water intake point:

Constituent	Concentration
Physical:	
Color (color units)	75
Inorganic Chemicals	**mg/l**
Alkalinity	30-500
Arsenic	0.05
Barium	1.0
Boron	1.0
Cadmium	0.01
Chloride	250
Chromium, hexavalent	0.05
Copper	1.0
Flouride	1.7
Iron (filterable)	0.3
Lead	0.05
Manganese (filterable)	0.05
Nitrates plus nitrites	10 (as N)
Selenium	0.01

Inorganic Chemicals (cont.)	mg/l (cont.)
Silver	0.05
Sulfate	250
Total dissolved solids (filterable residue)	500
Uranyl ion	5
Organic Chemicals	**mg/l**
Carbon chloroform extract (CCE)	0.15
Cyanide	0.20
Methylene blue active substances	0.5
Pesticides:	
Aldrin	0.017
Chlordane	0.003
DDT	0.042
Dieldrin	0.017
Endrin	0.001
Heptachlor	0.018
Heptachlor epoxide	0.018
Lindane	0.056
Methoxychlor	0.035
Organic phosphates plus Carbamates	0.1
Toxaphene	0.005
Herbicides:	
2, 4-D plus 2,4,5-T, plus 2, 4,5-TP	0.1
Phenols	0.001

Radioactivity:	pc/l
Gross beta	1,000
Radium-226	3
Strontium-90	10

2.00 RULES WITH SPECIFIC APPLICATION BASED ON CLIMATE, GEOGRAPHICAL AREA, OR USES

2.01 Primary Classification of Waters Within the State

MAJOR CLASS	GEOGRAPHICAL AREA or OTHER DESCRIPTION of WATERS	DISSOLVED OXYGEN mg/l		pH	TEMPERATURE °F	
		Minimum	Daily Average		Rise above Natural	Maximum
IV	Mountainous Zone	4.0	5.0	6.0-8.5	5	87

2.02 Subclasses to Complement Major Water Class Designations

Subclass A

Waters generally satisfactory for use as public or municipal water supply, secondary contact recreation, propagation of fish and aquatic life, and other beneficial uses.

Coliform Organisms - Fecal coliforms (multiple-tube fermentation or MF count) not to exceed a log mean of 1000/100 ml. Not to equal or exceed 2000/100 ml. in more than 10% of samples.

Monthly average value not more than 5000/100 ml. (MPN or MF count). Not more than 5000 MPN/100 ml. in more than 20% of samples in any month. Not more than 20,000/100 ml. in more than 5% of such samples.

Appendix B

Sample Station Descriptions

Station Number	Station Description	RMI	Latitude	Longitude
1	Back Creek at Virginia State Highway 39 bridge near Mt. Grove, Virginia	5.7	N38°04'48"	W79°53'50"
2	Jackson River at Boiling Springs Rod and Gun Club private bridge near Bacova, Virginia	397.0	N38°02'39"	W79°53'48"
3.	Jackson River at Allegheny (Va.) County Route 600 bridge (Kelly Bridge) near Allegheny-Bath County line	386.7	N37°57'10"	W79°57'57"
4	Jackson River at Allegheny (Va.) County 638 bridge at Natural Wells, Va.	380.1	N37°55'03"	W79°58'05"
5	Cedar Creek at Allegheny (Va.) County Route 605 bridge near Callison, Va.	2.3	N37°58'05"	W79°53'10"

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Appendix C

Water Quality Data Summary
Gathright Reservoir Project
1971 - 1972

Station 1 - Back Creek near Mt. Grove, Va.

	1971	1971	1971	1971	1972	1972	1972	1972	1972	1972
Date	7/8	10/6	11/18	12/13	2/24	4/6	5/4	6/8	8/1	9/8
Time	1420	1145	1045	1240	1150	1210	0730	1440	1115	1220
Tw°C	23	16	-	8	-	-	11	22	18	20
Total colif.	92	TNTC*	e 56	40	e 32	8	720	48	290	90
Fec.colif.	-	e 26**	e 4	40	1	2	200	27	56	8
Fecal Strep.	220	180	280	e 13	e 4	2	95	42	44	36
FC/FS Ratio	-	0.14	0.014	3.08	0.25	1:1	2.10	0.64	1.27	0.22
Field pH	8.2	7.3	8.3	7.5	7.0	7.4	6.9	7.7	7.4	8.0
Alkalinity	50	48	43	36	22	33	26	49	27	51
Conductivity	110	81	93	66	-	-	-	-	-	-
Color	-	5	5	5	5	-	-	-	-	-
Turbidity	1.4	1	0.7	3	3	-	-	-	6	0.5
D.O.(field)	8.8	9.1	11.4	10.9	11.2	10.8	9.7	8.5	9.5	9.2
BOD_5	4.5	1	1.1	+ 0.8	1	-	1	1	1	1
TOC	2	2	2	3	-	-	6	3	-	-
COD	1.14	0.6	3.9	4	-	1.6	26	6.7	2.2	13
Solids	-	-	49	38	73	107	112	133	81	95
Sus.Sol.	9.5	1	7.2	0.8	2.4	1	7.5	2.0	8.4	1.2
Hardness	57	48	43	26	21	17	44	37	18	60
Phos.	0.02	0.02	0.010	0.02	0.020	0.02	0.013	0.013	0.035	0.01
Ortho.Phos.	0	0.02	0.003	0.007	0.006	0.01	0.022	0.005	0.035	0.01
TKN	0.01	0.06	0.04	0.04	0.04	0.04	0.93	0.04	0.04	0.08
NH_3-N	0.01	0.01	0.01	0.01	0.04	0.04	0.05	0.04	0.005	0.005
NO_3-N	0.1	0.04	0.04	0.35	0.165	0.05	0.195	0.145	1.547	0.143
NO_2-N	0.01	0.003	0.005	0.006	0.003	0.004	0.005	0.005	0.003	0.001
SO_4	5	7	6	7	6	8	8	4	1	8
Fe	0.02	0.1	0.1	0.2	0.17	0.05	0.10	0.10	0.27	0.05
Mn	0	0.05	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Flow)cfs_	40	42	35	178	346	77	590	44	316	44

Lab analyses at Charlottesville, Va.
Project Officer: Melvin

\+ 6-day BOD value
* indicates plate overgrown with colonies merging
** estimated count; less than 20 counts per plate

Appendix D

Water Quality Data Summary
Gathright Reservoir Project
1971 - 1972

Station 2 - Jackson River near Bacova, Va.

	1971	1971	1971	1971	1972	1972	1972	1972	1972	1972
Date	7/8	10/6	11/18	12/13	2/24	4/6	5/4	6/8	8/1	9/8
Time	1420	1145	1045	1240	1150	1210	0730	1440	1115	1220
Tw°C	23	16	-	8	-	-	11	22	18	20
Total Colif.	92	TNTC*	e 56	40	e 32	8	720	48	390	90
Fec.Colif.	-	e 26	3 4	40	1	2	200	27	36	8
Fecal Strep.	220	180	280	e 13	e 4	2	95	42	44	26
FC/FS Ratio	-	0.192	0.13	0.947	2.83	1:1	3.07	0.45	0.526	0.450
Field pH	8.3	7.6	8.0	7.9	7.4	8.2	7.4	7.9	7.4	8.1
Alkalinity	86	92	86	73	54	74	47	90	68	91
Conductivity	180	160	180	140	-	-	-	-	-	-
Color	-	5	10	10	20	-	-	-	-	-
Turbidity	3.1	2	1.4	5	13	-	-	-	8	1.2
D.O.(field)	9.3	9.4	11.5	11.0	12.3	11.8	9.2	9.7	9.3	9.7
BOD_5	1.3	1	1.3	+1.4	1	-	-	1	1	1
TOC	1	2	3	3	-	-	6	4	-	-
COD	5.0	1.7	4.4	5	-	2.8	10	4.5	4.1	11
Solids	-	-	110	84	130	160	172	176	137	140
Sus.Sol.	12.5	1	7.2	2.8	19.2	1	30	1.6	14.4	3.6
Hardness	103	95	79	50	44	40	33	47	36	114
Phos.	0.02	0.02	0.017	0.04	0.033	0.02	0.050	0.023	0.145	0.015
Ortho Phos	0.01	0.01	0.001	0.03	0.018	0.01	0.043	0.005	0.042	0.01
TKN	0.01	0.28	0.04	0.04	0.04	0.83	0.04	0.04	0.04	0.04
NH_3-N	0.02	0.01	0.01	0.01	0.22	0.04	0.10	0.04	0.005	0.005
NO_3-N	0.1	0.08	0.02	0.41	0.246	0.01	0.194	0.160	1.984	0.150
NO_2-N	0.01	0.003	0.005	0.006	0.004	0.005	0.006	0.005	0.004	0.001
SO_4	16	9	15	9	8	12	11	11	6	18
Fe	0.07	0.1	0.1	0.2	0.80	0.08	0.20	0.14	0.37	0.05
Mn	0	0.05	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Flow(cfs)	46	51	29	200	340	92	600	62	305	45

Lab analyses at Charlottesville, Va.
Project Officer: Melvin

\+ 6 day BOD value
* indicates plate overgrown with colonies merging
** estimated count; less than 20 counts per plate

Appendix E

Water Quality Data Summary
Gathright Reservoir Project
1971 - 1972

Station 3 - Jackson River at Kelly Bridge

	1971	1971	1971	1971	1972	1972	1972	1972	1972	1972
Date	7/8	10/6	11/18	12/13	2/24	4/6	5/4	6/8	8/1	9/8
Time	1245	1015	0900	1115	1015	1050	0850	1000	1000	1100
Tw°C	23	16	-	8	3	-	13	17	17	18
Total Colif.	24	TNTC*	e 170	130	308	4	1800	52	970	140
Fec.Colif.	-	e 36**	e 4	38	27	0	660	8	100	18
Fecal Strep	130	160	640	44	e 8	0	410	12	140	90
FC/FS Ratio	-	0.225	0.006	0.863	3.37	-	1.609	0.67	0.714	0.20
Field pH	8.1	7.8	7.8	7.7	7.2	7.6	7.3	8.0	7.4	8.0
Alkalinity	74	77	73	56	40	58	42	76	47	83
Conductivity	160	150	160	105	-	-	-	-	-	-
Color	-	5	5	8	5	-	-	-	-	-
Turbidity	1.8	2	1.0	4	4	-	-	-	7	1.0
D.O.(field)	9.5	8.9	11.0	11.0	12.4	10.9	9.3	8.8	9.5	9.1
	0.137	0.225	0.255	0.073	0.081	-	0.108	0.114	0.105	0.110
BOD_5	1.3	2	2.8	+ 0.8	1	-	1	1	1	1
TOC	1	2	2	2	-	-	5	5	-	-
COD	3.5	1.7	4.2	6	-	1.6	7.4	1.9	8.6	2.1
Solids	-	-	90	56	119	120	167	157	126	114
Sus.Sol.	11.5	1	13	1.2	1.2	1	21.5	2.4	13.6	1.2
Hardness	86	96	70	36	32	30	31	74	27	100
Phos.	0.01	0.01	0.010	0.04	0.05	0.03	0.02	0.025	0.025	0.01
Ortho Phos.	0	0.01	0.001	0.04	0.01	0.01	0.022	0.005	0.020	0.01
TKN	0.01	0.39	0.04	0.04	0.04	0.52	0.04	0.04	0.04	0.04
NH_3-N	0.01	0.01	0.01	0.01	0.04	0.04	0.55	0.04	0.003	0.003
NO_3-N	0.1	0.03	0.01	0.38	0.175	0.01	0.143	0.103	1.687	0.110
NO_2-N	0.01	0.003	0.005	0.006	0.003	0.005	0.007	0.005	0.003	0.002
SO_4	9.6	10	12	8	8	11	8	8	4.2	16
Fe	0.05	0.1	0.1	0.2	0.31	0.07	0.14	0.11	0.29	0.03
Mn	0	0.05	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Flow(cfs)										

Lab analyses at Charlottesville, Va.
Project Officer: Melvin

\+ 6 day BOD value
* indicates plate overgrown with colonies merging
** estimated count; less than 20 counts per plate

Appendix F

Water Quality Data Summary
Gathright Reservoir Project
1971 - 1972

Station 4 - Jackson River at Natural Wells, Va.

	1971	1971	1971	1971	1972	1972	1972	1972	1972	1972
Date	7/8	10/16	11/18	12/13	2/24	4/6	5/4	6/8	8/1	9/8
Time	1200	0950	0845	1050	0945	1020	0930	0900	0940	0845
Tw°C	23	17	-	8	3	-	14	17	17	18
Total Colif.	40	TNTC*	e 200	100	360	4	1000	76	830	130
Fec. Colif.	-	e 30**	34	e 19	e 14	0	600	38	150	18
Fecal Strep.	160	240	40	e 35	3 14	0	420	8	150	98
FC/FS Ratio	-	0.125	0.85	0.54	1:1	-	1.43	4.75	1:1	0.183
Field pH	8.3	6.9	7.9	7.7	7.1	7.8	7.4	8.0	7.6	8.1
Alkalinity	85	71	82	50	43	64	44	84	49	93
Conductivity	220	160	180	110	-	-	-	-	-	-
Color	-	5	10	7	5	-	-	-	-	-
Turbidity	3.3	2	1.4	4	5	-	-	-	8	1.2
D.O(field)	10.3	9.6	11.3	11.3	12.7	12.2	9.2	9.4	9.3	9.3
BOD_5	1.0	1	1.2	+ 1.2	4	-	1	1	1	1
TOC	1	2	2	3	-	-	3	5	-	-
COD	4.3	2.3	2.8	6	-	2.0	8.5	8.6	4.5	1.3
Solids	-	-	100	67	105	126	169	171	126	138
Sus.Sol.	13.0	1	6.0	1.2	1.2	1	17	0.4	12.8	2.8
Hardness	42	96	81	42	35	35	37	74	26	119
Phos.	0.02	0.01	0.007	0.02	0.020	0.02	0.025	0.023	0.04	0.01
Ortho Phos.	0.01	0.01	0.003	0.01	0.01	0.01	0.025	0.005	0.030	0.01
TKN	0.01	0.11	0.04	0.04	0.04	0.40	0.04	0.04	0.04	0.04
NH_3-N	0.01	0.01	0.01	0.01	0.04	0.04	0.05	0.04	0.005	0.006
NO_3-N	0.1	0.04	0.02	0.37	0.220	0.01	0.105	0.103	1.797	0.100
NO_2-N	0.01	0.003	0.005	0.002	0.003	0.004	0.005	0.005	0.003	0.001
SO_4	28.3	15	15	8	14	12	11	8	4	19
Fe	0.05	0.1	0.1	0.2	0.3	0.7	0.13	0.09	0.46	0.05
Mn	0	0.05	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Flow(cfs)	176	184	151	533	667	272	1291	215	1115	137

Lab analyses at Charlottesville, Va.
Project Officer: Melvin
+ 6 day BOD value
* indicates plate overgrown with colonies merging
** estimated count; less than 20 counts per plate

Appendix G

Water Quality Data Summary
Gathright Reservoir Project
1971 - 1972

Station 5 - Cedar Creek near Callison, Va.

	1971	1971	1971	1971	1972	1972	1972	1972	1972	1972
Date	7/8	10/6	11/18	12/13	2/24	4/6	5/4	6/8	8/1	9/8
Time	-	1305	1130	0930	1250	0930	1010	1250	0845	1010
Tw°C	-	17	-	9	-	-	13	18	15	10
Total Colif.	-	TNTC*	e 120**	360	1300	20	1500	88	1500	720
Fec.Colif.	-	e 14	e 1	31	TNTC	8	480	17	110	130
Fecal Strep	-	130	58	e 39	360	6	510	38	170	34
FC/FS Ratio	-	0.107	0.017	0.794	-	1.33	0.941	0.447	0.647	3.82
Field pH	-	8.2	8.6	8.2	7.6	8.2	7.8	8.5	8.1	8.4
Alkalinity	-	150	150	128	58	134	61	157	97	173
Conductivity	-	320	380	240	-	-	-	-	-	-
Color	-	5	5	6	50	-	-	-	-	-
Turbidity	-	2	1.1	3	43	-	-	-	9	1.4
D.O.(field)	-	10.4	13.6	11.0	12.1	12.4	10.1	10.7	9.5	10.2
BOD_5	-	1	1.1	+ 0.8	1	-	1	1	1	1
TOC	-	2	5	3	-	-	4	4	-	-
COD	-	0.3	8.0	4	-	1.6	8.1	54	3.0	3.1
Solids	-	-	220	172	202	247	198	285	193	244
Sus.Sol.	-	2	7.2	3.6	59.6	2	18	2.4	20.6	2.8
Hardness	-	180	190	100	52	81	49	158	47	235
Phos.	-	0.15	0.120	0.11	0.07	0.08	0.050	0.105	0.07	0.130
Ortho Phos.	-	0.15	0.110	0.09	0.032	0.06	0.050	0.103	0.070	0.130
TKN	-	0.62	0.04	0.22	0.04	0.68	0.04	0.04	0.04	0.04
NH_3-N	-	0.01	0.01	0.01	0.12	0.04	0.32	0.04	0.005	0.104
NO_3-N	-	0.12	0.21	0.53	0.218	0.24	0.347	0.328	1.097	0.300
NO_2-N	-	0.003	0.005	0.002	0.012	0.004	0.007	0.005	0.003	0.001
SO_4	-	57	57	34	13	43	19	38	17	17
Fe	-	0.1	0.1	0.2	2.0	0.06	0.18	0.03	0.28	0.05
Mn	-	0.05	0.05	0.03	0.05	0.02	0.02	0.02	0.02	0.02
Flow(cfs)	-	15.3	12.0	44.6	104.2	24.8	137.4	10.3	85.5	8.0

Lab analyses at Charlottesville, Virginia
Project Officer: Melvin
+ 6 day BOD
* indicates plate overgrown with colonies merging
**estimated count; less than 20 counts per plate

APPENDIX H

PRELIMINARY BIOLOGICAL SYNOPSIS OF THE GATHRIGHT PREIMPOUNDMENT STUDIES OF NOVEMBER 11, 1971, and OCTOBER 9, 1972

Station #1 - This station was located on Back Creek at the Virginia Route 39 Bridge, west of Warm Springs, Virginia.

This station was originally sampled on November 11, 1971, and high water quality was indicated by twenty genera of bottom organisms. Clean water associated forms consisted of stoneflies (3 genera), mayflies (3 genera), caddisflies (5 genera) riffle beetles (2 genera) and a gill breathing snail.

There were 139 bottom organisms per square foot dominated by the following groups: midge larvae (41), mayflies (31), caddisflies (28), and riffle beetles (19).

Station #2 - This station was located on the Jackson River upstream from Back Creek at the U.S.G.S. Staff Gage.

The water was very clear and fish, including trout and suckers, were observed. High water quality was indicated by the sixteen genera of bottom organisms which included such clean water associated forms as stoneflies, mayflies (3 genera) caddisflies (3 genera), hellgrammites, and riffle beetles. The square foot sample was only 32 organisms per square foot, but this is believed to be mainly due to the substrate which wasprimarily bedrock and the small amount of vegetation which did not allow a large population to develop at this station.

The quantitative sample was dominated by caddisflies (19) and mayflies (4).

Station #4 - This station was located on the Jackson River downstream at Kelly Bridge.

The water was quite clear and numerous minnows were observed. Sunfish, darters (related to yellow perch and walleyes) and tadpoles were also present.

Elodea was the dominant aquatic vegetation.

Very high water quality was indicated by the 29 genera which included such clean water associated forms as stoneflies (2), mayflies (3), caddisflies (5), fishflies, hellgrammites, and riffle beetles (3).

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There were 361 organisms in the square foot sample which were dominated by caddisflies (102), air breathing snails (74, riffle beetles (50), mayflies (45), and midges (43).

Station #5 - This station was located on Cedar Creek, a tributary to the Jackson River.

The water at this station was extremely clear and numerous minnows were observed. In addition, smallmouth bass and sunfish were present.

High water quality was indicated by the twenty-three genera of bottom organisms which included clean water associated stoneflies (2 genera), mayflies (4 genera), caddisflies (3 genera), fishflies, and riffle beetles (3 genera).

The square foot sample contained 1,143 bottom organisms. The dominant forms were caddisflies (436), mayflies (204), craneflies (179), midge larvae (176), and riffle beetles, (108). An indication of the high water quality was the presence of 19 stoneflies, a very unusually high number for this very sensitive form.

REFERENCES

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(3) Water Supply and Water Quality Control Study - James River Basin, Virginia, Dept. HEW, PHS Region III, Charlottesville, Va., 1965

(4) Standard Methods for Examination of Water and Wastewater APHA 13th ed.

(5) Industrial Waste Guide on Thermal Pollution
USDI, FWPCA Northwest Region
Pacific Northwest Water Lab, Corvallis, Ore., Sept. 1968

(6) MacKenthum, Kenneth M & W. M. Ingram, Biological Associated Problems in Freshwater Environments, FWPCA, 1967, 287 p.

1140 River Road, Charlottesville, Virginia 22901

UNITED STATES GOVERNMENT

Memorandum

ENVIRONMENTAL PROTECTION AGENCY
Region III
Charlottesville Field Office

TO : Norman Melvin

DATE: September 27, 1972

FROM : Al Bouldin
Charlottesville Field Office

SUBJECT: Cathright Pre-impoundment Study - Bacterial Assessment

The water quality in the Cathright Pre-impoundment area, from a bacteriological point of view, is quite good. At most of the stations in most of the sampling periods, the water easily meets Virginia State Water Quality Standards for water supply and primary contact recreation.

The only time when fecal coliform counts were a little elevated was at the May sampling. This might easily be attributed to increased spring run-off. Weather reports should be checked to confirm this.

The only source of pollution suggested by most of the accumulated data is animal in nature, which could be expected by a visual survey of the area. This is supported by the fecal coliform/fecal streptococcus ratio (FC/FS) at the stations. This ratio is most reliable when the fecal coliforms and fecal strep counts are attributable to a pollution source not more than 24 hours flow upstream from the sampling location. This time period may not be definitely established for the prescribed sampling locations, nevertheless, the ratios still should be indicative of animal pollution primarily.

It does not appear than an impoundment would have an adverse effect on the water quality of this area. There does not appear to be any definite continuous source of pollution emptying into this watershed that would cause elevated counts if contained. As long as there are no human sources of pollution discharging into the impoundment, the water quality should remain acceptable for primary contact recreation, water supply, etc.

One suggestion for the filling period would be monitoring for fecal coliform and fecal strep counts during periods of elevated run-off, especially if there are to be beach and primary contact areas in the impoundment.

Al Bouldin

Attachments

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan